QUARZ Test and Qualification Center for Concentrating Solar Power Technologies

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DLR

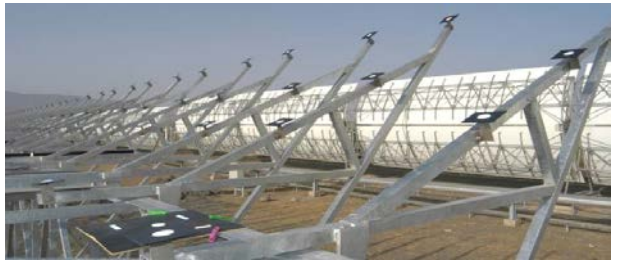
Objective

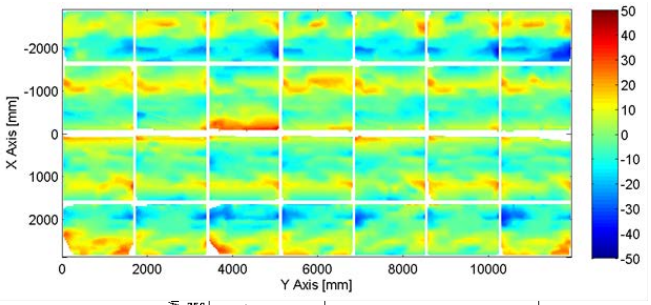
- Fairly asses quality of components of CSP Systems
- Develop technological basis for standards

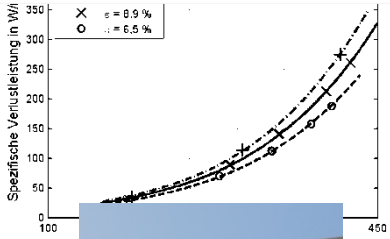
⇒QUARZ Test and Qualification Center built in 2009 at DLR Cologne

Component Evaluation

- Collector structure
  - Mounting points
  - Rigidity
- Reflector panels
  - Reflectivity
  - slope deviation
  - Intercept factor
- Receivers /
  - Heat losses (25-400°C)
  - Optical effciency
- Flexible connectors
  - Pressure loss
- Tracking system
  - Tracking accuracy

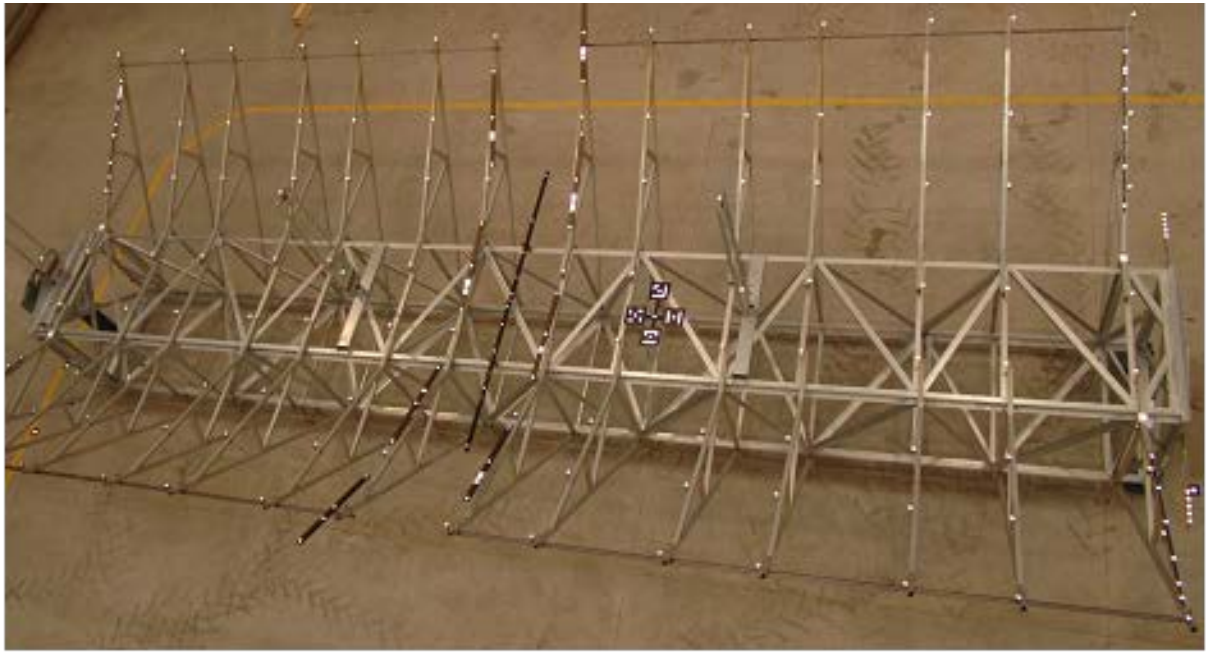






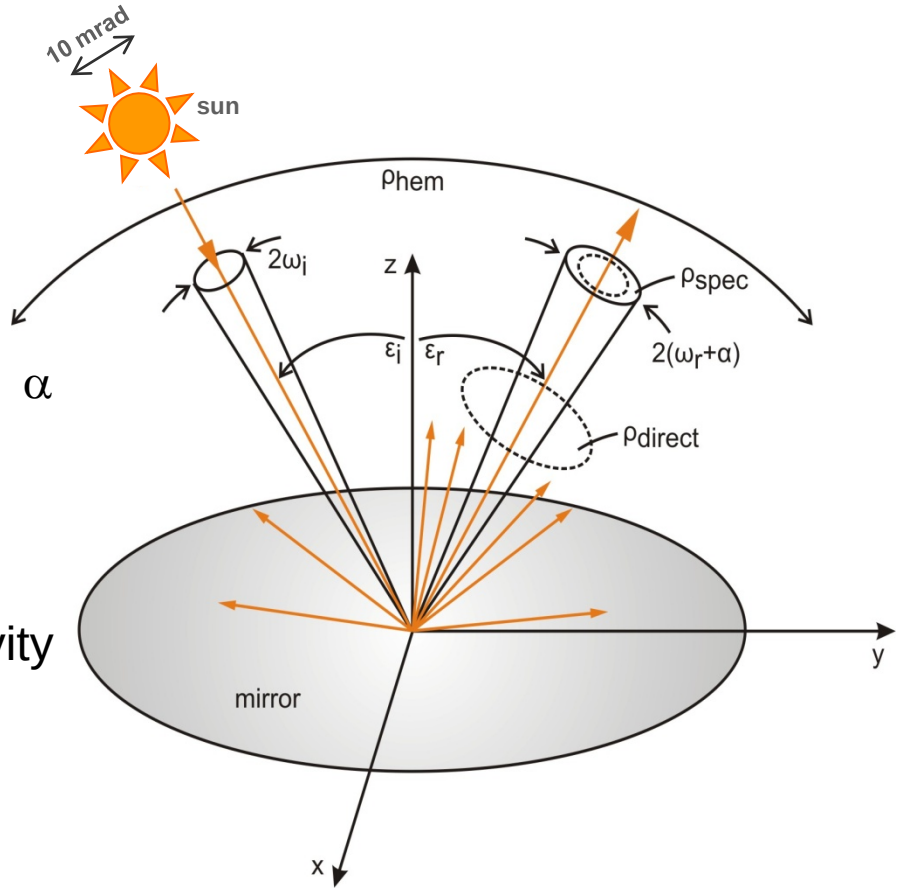
Mounting Points

- Method: Photogrammetrie



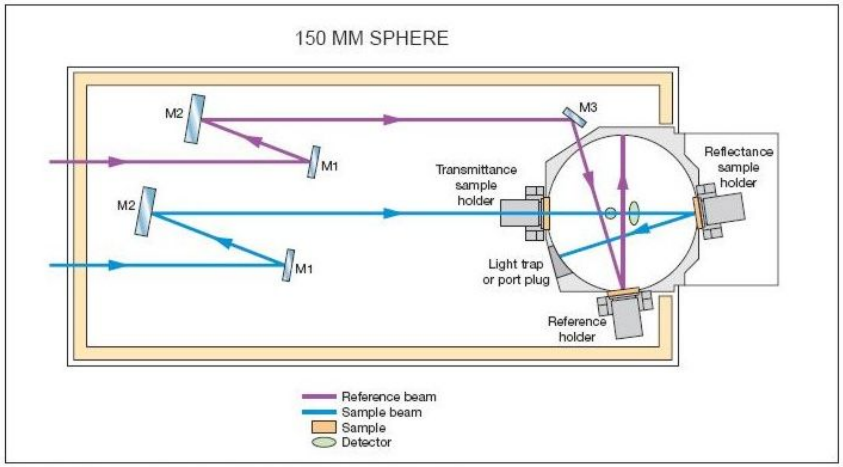
Reflectivity Parameter

- ρ_{spec} = specular reflectivity
- α = half angle of beam spread
- ρ_{direct} = ρ_{spec} + directed diffusion within α
- ρ_{SWD} = ρ_{direct} solar weighted
- ρ_{hem} = spektral hemispherical reflectivity
- ρ_{SWH} = ρ_{hem} solar weighted



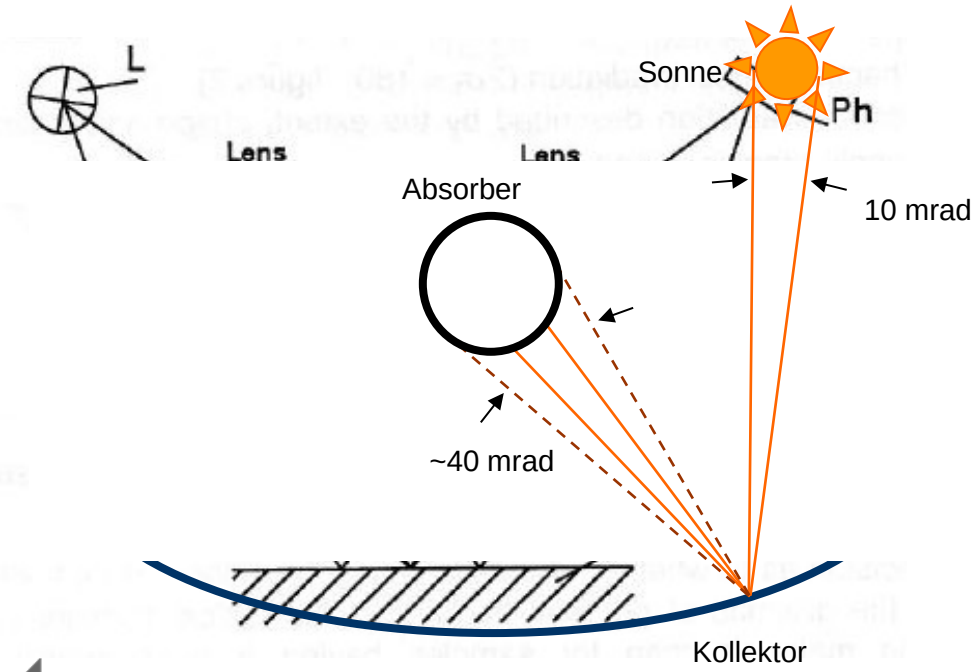
Spektral hemispherical Reflectivity ρ_{hem}

- *Perkin Elmer Lambda 950*
- Integrating sphere
- Wavelenth range 250 – 2500 nm



Measurement direct Reflectivity ρ_{direct}

- *Devices & Services R15 portable Reflectometer*
- 25 mrad Aperture



Solar weighted Reflectivity

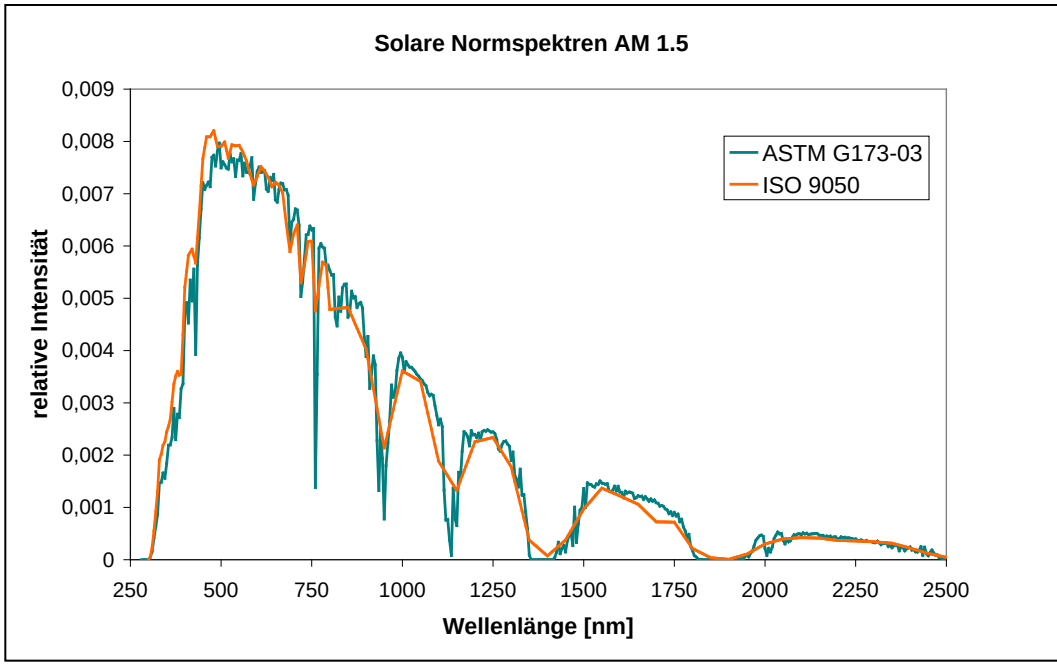
ASTM G173-03 direkte Solareinstrahlung AM 1.5 (Bsp. ρ_{SWH} = 0,903)

ISO 9050 globale Solareinstrahlung AM 1.5 (Bsp. ρ_{SWH} = 0,900)

$\rho_{SWH} = \int \rho_{\mathrm{direct}}(\lambda) I(\lambda) d\lambda \; / \int I(\lambda) d\lambda$

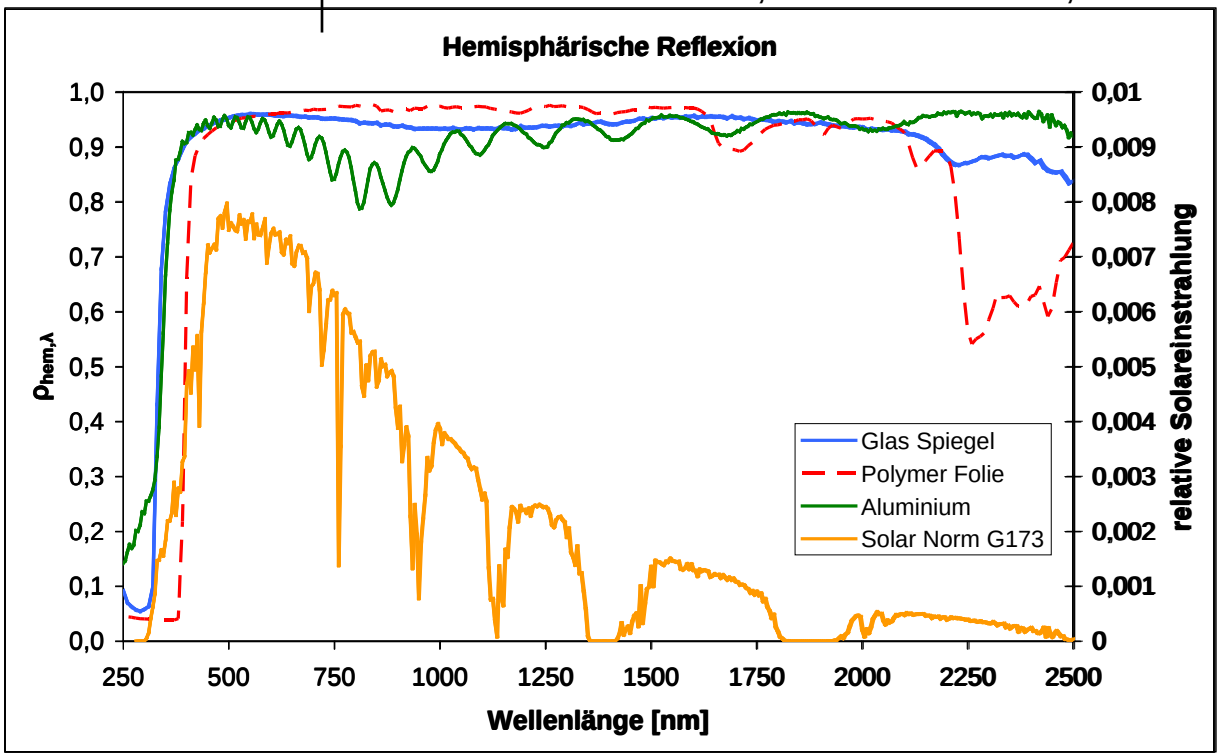
$\rightarrow$ ($\rho_{direct}(\lambda)$ / $\rho_{hem}(\lambda)$) ≈ const

$$\rho_{SWD} = \frac{\rho_{direct,660}}{\rho_{hem,660}} \cdot \rho_{SWH}$$

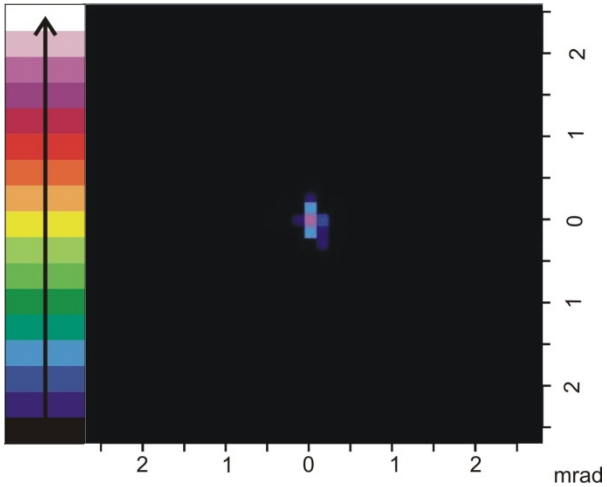


Example

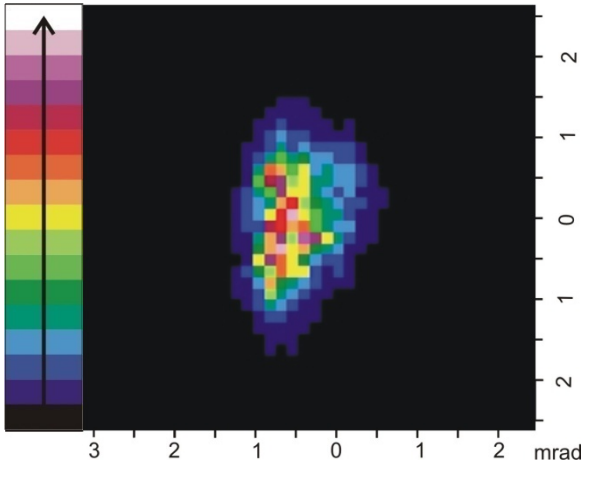
	Glass	Aluminium	Polymer
ρ_{SWH} G173	0,939	0,903	0,922
ρ_{SWD} G173	0,939	0,830	0,874
Glanz	1	0,92	0,95



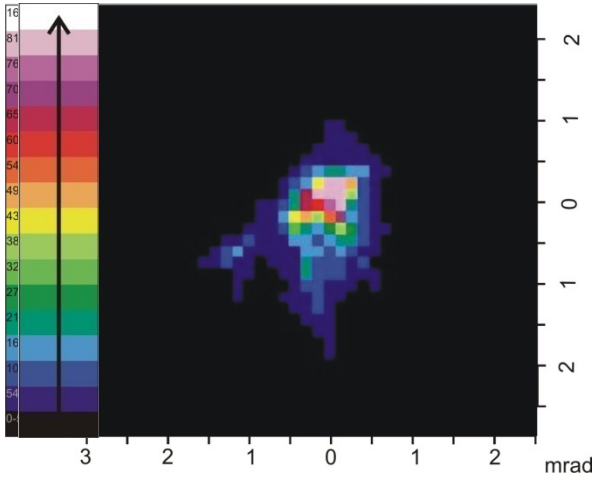
Example



Glass



Aluminium



Polymer

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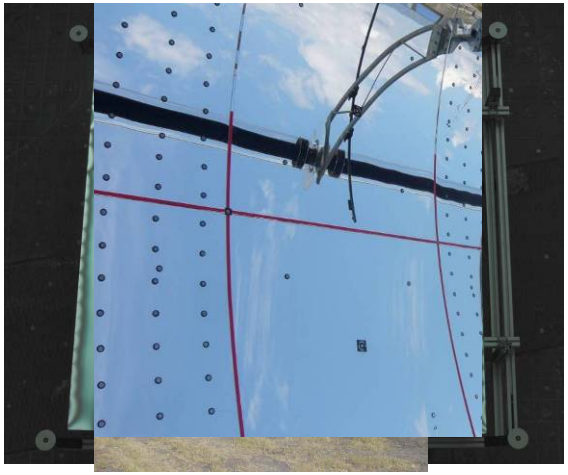
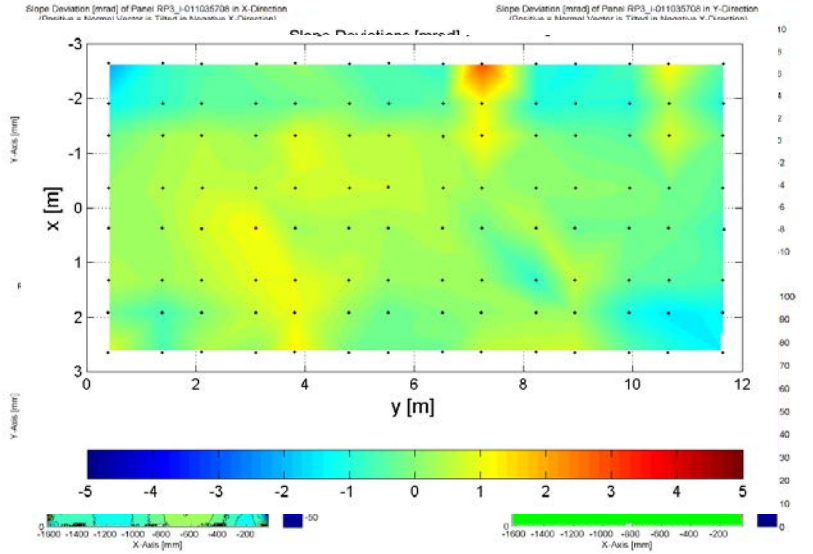
Optical Performance

Methods: Photogrammetry and Deflectometry

- Laboratory
  - single mirror panels
    - SDx, SDy, FDx, Intercept
- Field
  - entire collector module
    - SDx, FDx, Intercept
    - 3D coordinates of
      - mirror points
      - HCE
      - axis of rotation

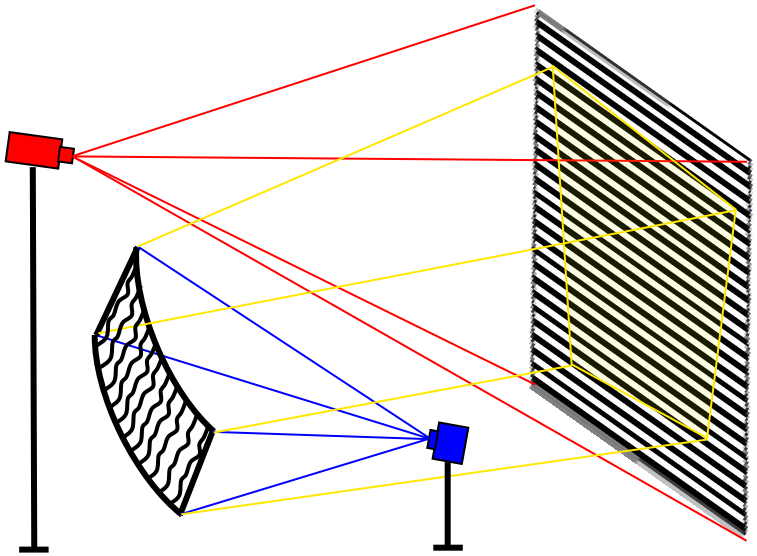


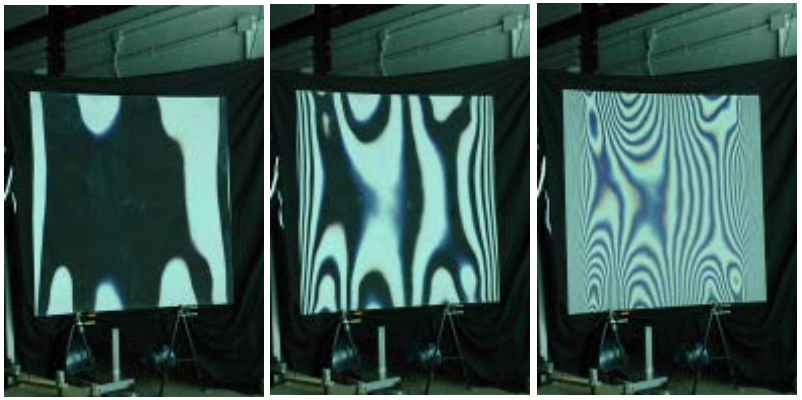


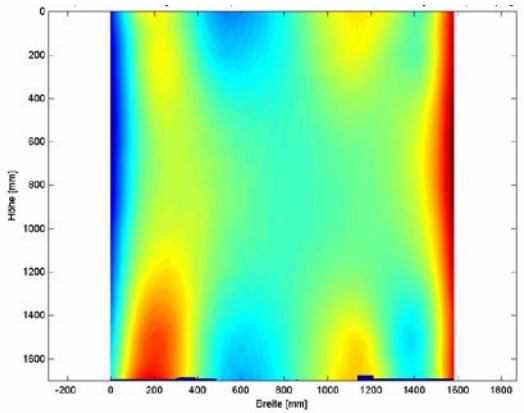
QUARZ™ Mirror shape measurement

Method: Deflectometry

Principle







Solar Simulator Receiver Test Rig (ElliRec)

- $\eta_{opt,rec}$

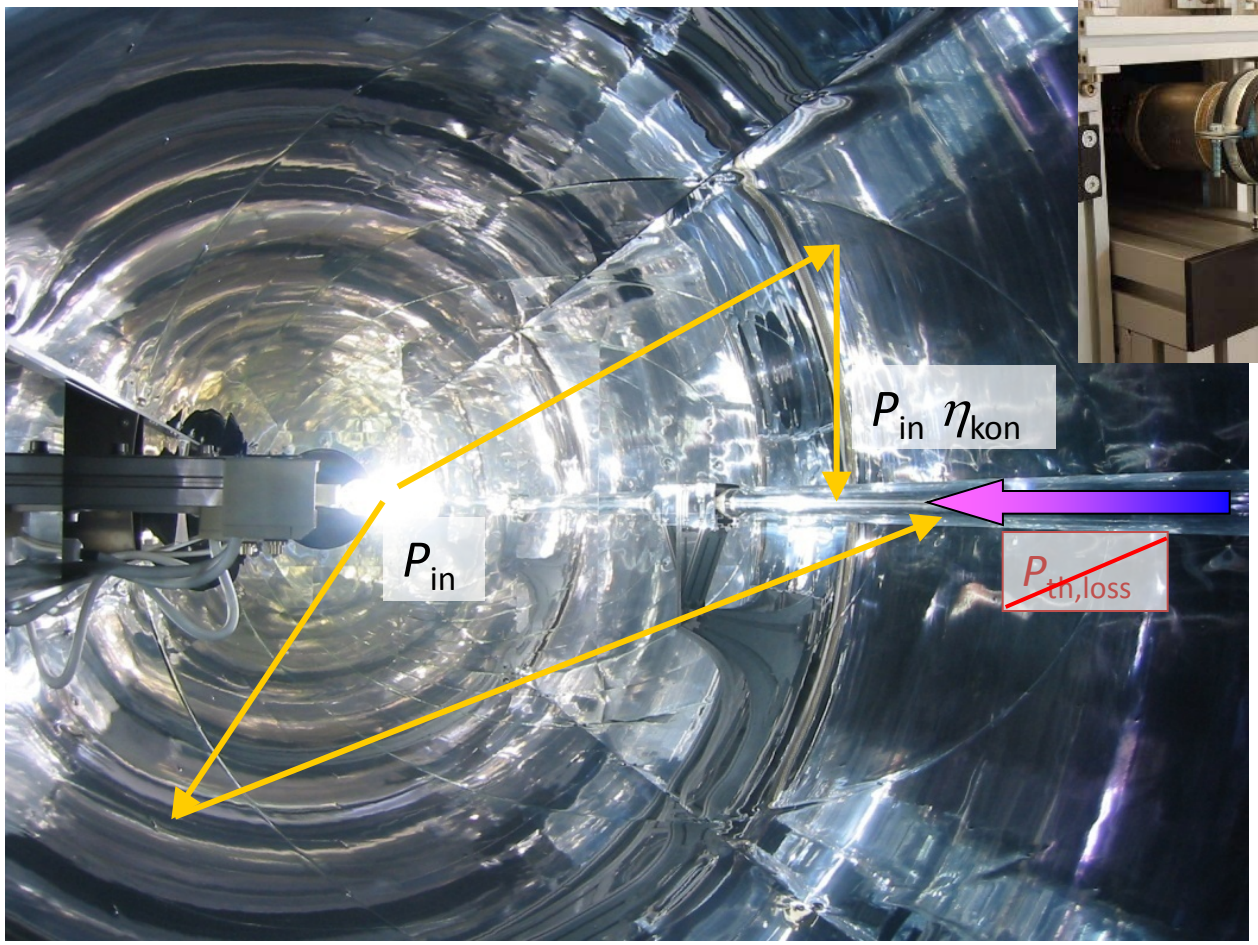
Solar Simulator Receiver Test Rig (ElliRec)

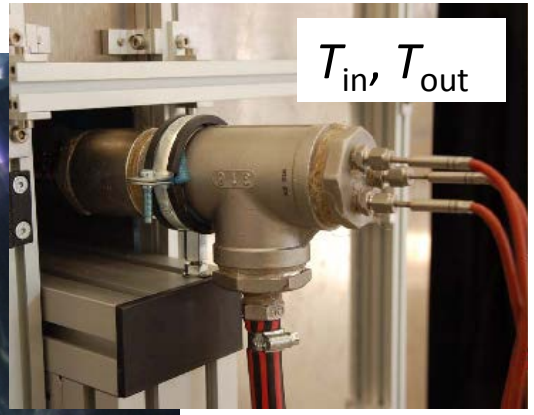
HMI-Lamps

1,2 kW

2,5 kW

4 kW



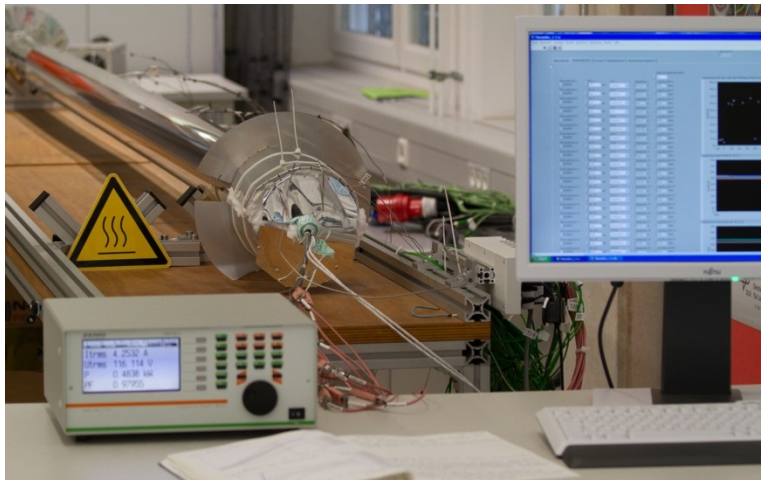


→ ~ $\eta_{opt,rec}$

QUARZ: Receiver heat loss testing

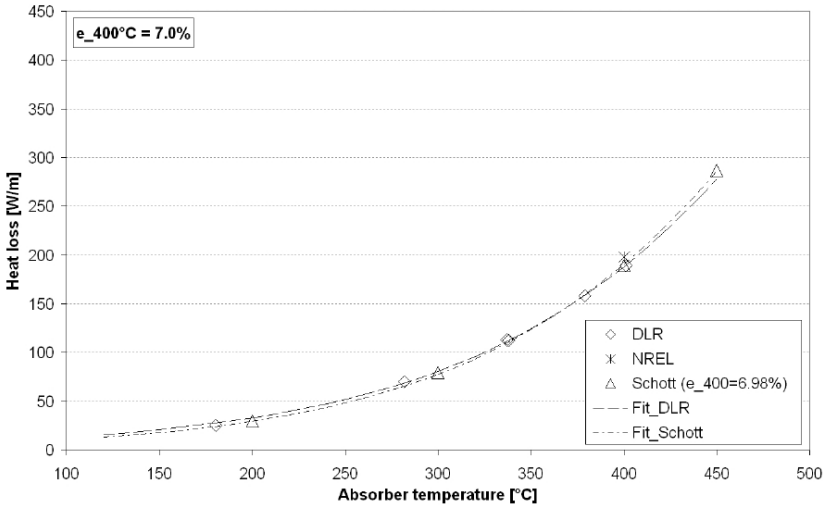
Measurements:

- Principle: Electrical Heating = Heat Loss



Features:

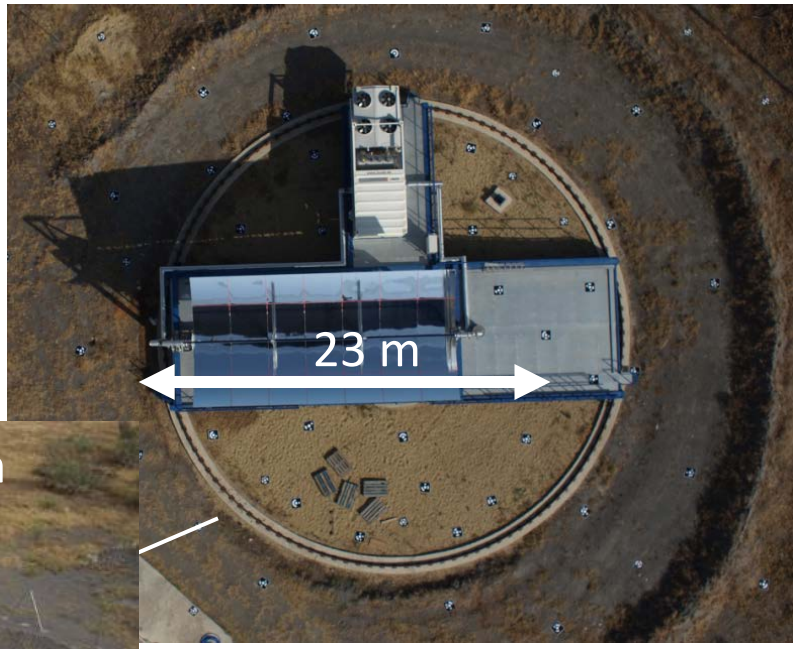
- Internal Electric Heating
- End Heaters for Homogeneous Temperature Profile
- Temperature Measurement of
  - Absorber inside
  - Glass Envelope
  - End Caps Surface
- Calculation of Axial End Losses (~3%) and Correction of Power



Rotating Plattform KONTAS

Spezifikationen

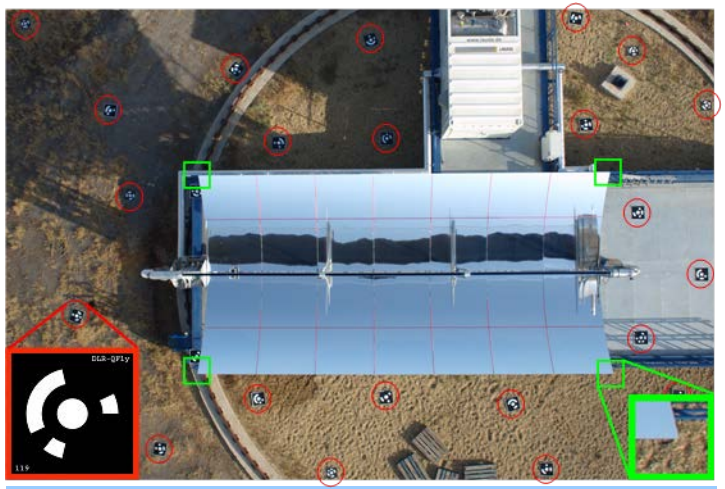
- Modules < 20 m
- HTF: Syltherm 800
- Rotation : 340°
- 6 kg/s
- 400 °C



QFly: Flying Camera for optical assessment of parabolic troughs

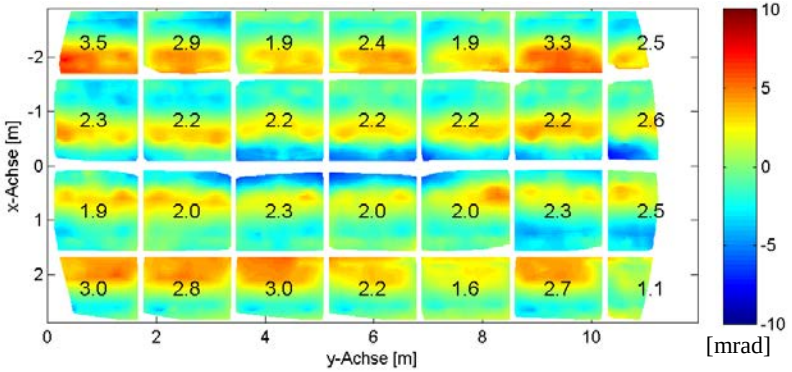
a) Test with QFLYin KONTAS facility (PSA)

b) automatic flight routing



c) photogrammetric measurement of camera and collektor position

- Uncertainty
  RMS of module:approx. 0,1 mrad



d) Slope deviaion of KONTAS collektor measured with QFly

Summary

- Measurement Instruments
  - Hemispherical and specular reflectivity
- Thermal heat loss receiver test rig (ThermoRec)
  - Electrical heating
  - Heat loss measurement $P_{th,loss}(T_{abs}-T_{amb})$
- Solar Simulator Receiver Test rig (ElliRec)
  - Lamps → independet of sunshine
  - Reproducible test conditions
  - Relative measurement of $\eta_{opt,rec}$
- Rotating Plattform Kontas
  - Measurement of collector Module
  - Efficiencyiy collector module η_K